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THE CLAIMS

What is claimed is:

- 5 1. A method for reducing roughness on a free surface of a semiconductor wafer which comprises applying a rapid thermal annealing process under a pure argon atmosphere for a time sufficient to uniformly heat and smooth the free surface of the wafer.
- 10 2. The method of claim 1 which further comprises, prior to conducting rapid thermal annealing, implanting atoms under a face of a donor substrate to form a zone of weakness, bonding a stiffening substrate to the face, and detaching the donor substrate along the zone of weakness to form the wafer including the stiffening substrate and a useful layer.
- 15 3. The method of claim 1 which further comprises rapid thermal annealing at a high temperature dwell in the range of about 1000°C to 1400°C, for a period in the range of about 1 second to 60 seconds.
- 20 4. The method of claim 3 wherein the high temperature dwell is in the range of about 1100°C to 1250°C, for a period in the range of about 5 seconds to 30 seconds.
5. The method of claim 1 which further comprises polishing the wafer after the rapid thermal annealing.
- 25 6. The method of claim 1 which further comprises implementing at least one sacrificial oxidation stage to reduce slip lines in the free surface of the wafer.
7. The method of claim 6 wherein the sacrificial oxidation stage is conducted prior to the rapid thermal annealing.
- 30 8. The method of claim 6 wherein the sacrificial oxidation stage is conducted after the rapid thermal annealing.

9. The method of claim 6 wherein a first sacrificial oxidation stage is conducted prior to the rapid thermal annealing, and a second sacrificial oxidation stage is conducted after the rapid thermal annealing.

5 10. The method of claim 9 which further comprises conducting a polishing stage after the rapid thermal annealing and prior to the second sacrificial oxidation stage to further enhance free surface smoothness.

10 11. The method of claim 6, wherein the rapid thermal annealing is followed by a first sacrificial oxidation stage, a polishing stage and a second sacrificial oxidation stage to further enhance free surface smoothness after the rapid thermal annealing.

12. The method of claim 5 which further comprises another rapid thermal annealing stage under pure argon after polishing to further enhance free surface smoothness.

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13. The method of claim 5 which further comprises conducting a first sacrificial oxidation stage prior to the polishing stage.

20 14. The method of claim 5 which further comprises conducting a second sacrificial oxidation stage after the polishing stage.

15. The method of claim 1 which further comprises forming a silicon-on-insulator structure having a free surface with enhanced smoothness.

25 16. A method for reducing roughness of a free surface of a wafer of semiconductor material which comprises:

placing a wafer into a chamber;

introducing an annealing atmosphere of pure argon into the chamber at a predetermined pressure;

30 heating the chamber to increase temperature inside the chamber at a predetermined rate up to a treatment temperature;

maintaining the wafer in the chamber at the treatment temperature for a duration of a high-temperature dwell; and

cooling the wafer at a rate of several tens of degrees Celsius per second.

5 17. The method of claim 16 wherein the predetermined pressure is equal to a few millitorr up to atmospheric pressure.

18. The method of claim 16 wherein the predetermined heating rate is about 50°C per second.

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19. The method of claim 16 which further comprises heating by rapid thermal annealing at a high temperature dwell in the range of about 1000°C to 1400°C for a period in the range of about 1 second to 60 seconds.

15 20. The method of claim 16 wherein cooling occurs by means of a flow of air.